CLAIMS

What is claimed is:

1. A sensor for a selected analyte in test solution, comprising:

a test vessel;

a semipermeable membrane with pores for retaining the analyte, dividing said test vessel into a first volume and a second volume, wherein said membrane is chemically modified by attachment of membrane modifiers on at least a side facing said first volume;

immunoassay labels disposed within said first volume which have label binding ligands where these label binding ligands will have a binding affinity for the membrane modifiers in the presence of the analyte, and a measurably different binding affinity for said membrane modifiers in the absence of the analyte;

a pressure source, for driving said test solution from said first volume into said second volume; and

a label detecting system, for detecting the presence or absence of said labels on said membrane.

2. The sensor of claim 1, wherein said membrane has pores not greater than 25 nm in diameter.

3. The sensor of claim 1, wherein said membrane has pores not greater than 10 nm in diameter.

4. The sensor of claim 1, wherein said membrane has a pore density of at least $10^{12}/m^2$.

5. The sensor of claim 1, wherein said membrane has a pore density of at least $10^{15}/m^2$.

6. The sensor of claim 1, wherein said membrane is essentially flat and optically translucent.

7. The sensor of claim 1, wherein said membrane supports a 100 kPa pressure load.

8. The sensor of claim 1, wherein said membrane is an etched aluminum membrane.

9. The sensor of claim 1, wherein said membrane modifiers are selected from the group consisting of haptens, antibodies, nucleic acids, proteins, chelating agents, and selective binding polymers, and wherein said bead modifiers are selected from the group consisting of haptens, antibodies, nucleic acids, polypeptides, glycolipids, hormones, chelating agents, metal ions, and selective binding polymers.

10. The sensor of claim 1, wherein said membrane has one or more regions with said attached membrane modifiers, and one or more additional regions adapted for resistance to nonspecific adsorption.

11. The sensor of claim 1;

wherein said sensor further comprises an adjustable magnetic field source, adapted for producing an adjustable magnetic field for exerting a force on said beads; and

wherein said labels comprise one or more magnetically active beads which have been chemically modified by attachment of bead modifiers capable of undergoing a selective binding interaction, wherein said bead modifiers will have a binding affinity for said membrane modifiers in the presence of said analyte, and a measurably different binding affinity for said membrane modifiers in the absence of said analyte;

wherein said label detecting system comprises an imaging system, adapted for observing individual beads bound to said substrate.

12. The sensor of claim 11, wherein said imaging system comprises an optical microscope, a digital image acquisition system, a digital image processing system, for identifying images of beads, and a counting system adapted for counting images of beads.

13. The sensor of claim 11, wherein said beads have an average diameter between about 0.2 μm and about 200 μm.

14. The sensor of claim 11, wherein said adjustable magnetic field source is adapted for applying a field on said magnetically active beads that is essentially normal to said membrane.

15. A sensor for independently detecting a plurality of analytes in a test solution, comprising:

a test vessel;

a semipermeable membrane with pores for retaining the analyte, dividing said test vessel into a first volume and a second volume, wherein said membrane is chemically modified by attachment of at least two distinct membrane modifiers on at least a side facing said first volume, wherein said at least two distinct membrane modifiers are patterned into an array of distinct regions on said membrane;

at least two distinct groups of immunoassay labels disposed within said first volume, wherein each of said groups of immunoassay labels has distinct label binding ligands where these label binding ligands will have a binding affinity for one of said distinct membrane modifiers in the presence of the analyte, and a measurably different binding affinity for said one of said distinct membrane modifiers in the absence of the analyte;

a pressure source, for driving said test solution from said first volume into said second volume; and

a label detecting system, for detecting the presence or absence of said labels in each of said regions on said membrane.

16. A method for detecting a selected analyte in test solution, comprising:

flowing said test solution through a semipermeable membrane having pores for retaining the analyte, wherein said membrane is chemically modified by attachment of membrane modifiers, so that said analyte contacts said membrane modifiers;

contacting said membrane with immunoassay labels, said immunoassay labels having label binding ligands, where these label binding ligands have a binding affinity for the membrane modifiers in the presence of the analyte, and a measurably different binding affinity for said membrane modifiers in the absence of the analyte; and

dectecting the presence or absence of said labels on said membrane.